
Devices for cell transplantation into the central nervous system: Design considerations and emerging technologies.

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Public Summary:

Successful use of cell-based therapies for the treatment of neurological diseases is dependent upon effective delivery to the central nervous system (CNS). The CNS poses several challenges to the delivery of cell-based therapeutics, including the blood-brain barrier, anatomic complexity, and regional specificity. Targeted delivery methods are therefore required for the selective treatment of specific CNS regions. In addition, CNS tissues are mechanically and physiologically delicate and even minor injury to normal brain or spinal cord can cause devastating neurological deficits. Targeted delivery methods must therefore minimize tissue trauma. At present, direct injection into brain or spinal cord parenchyma promises to be the most versatile and accurate method of targeted CNS therapeutic delivery. While direct injection methods have already been employed in clinical trials of cell transplantation for a wide variety of neurological diseases, there are many shortcomings with the devices and surgical approaches currently used. Some of these technical limitations may hinder the clinical development of cell transplantation therapies despite validity of the underlying biological mechanisms. In this review, we discuss some of the important technical considerations of CNS injection devices such as targeting accuracy, distribution of infused therapeutic, and overall safety to the patient. We also introduce and discuss an emerging technology - radially branched deployment - that may improve our ability to safely distribute cell-based therapies and other therapeutic agents to the CNS. Finally, we speculate on future technological developments that may further enhance the efficacy of CNS therapeutic delivery.

Scientific Abstract:

Successful use of cell-based therapies for the treatment of neurological diseases is dependent upon effective delivery to the central nervous system (CNS). The CNS poses several challenges to the delivery of cell-based therapeutics, including the blood-brain barrier, anatomic complexity, and regional specificity. Targeted delivery methods are therefore required for the selective treatment of specific CNS regions. In addition, CNS tissues are mechanically and physiologically delicate and even minor injury to normal brain or spinal cord can cause devastating neurological deficits. Targeted delivery methods must therefore minimize tissue trauma. At present, direct injection into brain or spinal cord parenchyma promises to be the most versatile and accurate method of targeted CNS therapeutic delivery. While direct injection methods have already been employed in clinical trials of cell transplantation for a wide variety of neurological diseases, there are many shortcomings with the devices and surgical approaches currently used. Some of these technical limitations may hinder the clinical development of cell transplantation therapies despite validity of the underlying biological mechanisms. In this review, we discuss some of the important technical considerations of CNS injection devices such as targeting accuracy, distribution of infused therapeutic, and overall safety to the patient. We also introduce and discuss an emerging technology - radially branched deployment - that may improve our ability to safely distribute cell-based therapies and other therapeutic agents to the CNS. Finally, we speculate on future technological developments that may further enhance the efficacy of CNS therapeutic delivery.

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